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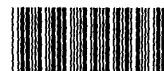
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09/105733  
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### Box: PATENT APPLICATION

Assistant Commissioner for Patents  
Washington, D.C. 20231

Attorney Reference: WOO 108

Re: New Patent Application of: Kuan-Chou CHEN, Ping-Yu HU,  
Kuei-Jung CHEN, Tzong-Ming WU, Wu-Lang LIN, and Wen-Yo LEE

Title: FRONT-OPENING UNIFIED POD AUTO-LOADING STRUCTURE

Sir:

Please find attached hereto an application for patent which includes:

- ☒ [x] Specification, Claims and Abstract (20 pages)
- ☒ [x] 7 Sheets of Formal Drawings (Fig. 1 through Fig. 6)
- ☒ [x] Inventor's Declaration and Power of Attorney (2 Pages)
- ☒ [x] Claim for priority and Priority document
- ☒ [x] Assignment document with cover page (4 Pages)
- ☒ [x] Fee (see formula below)
- ☐ [ ] Small entity form ( Page)

Basic Fee \$355/710

\$ 710.00

Additional Fees:

Total number of claims: 17

\$ 0.00

in excess of 20: 0 times \$9/18

Number of independent claims: 1

\$ 0.00

in excess of 3: 0 times \$40/80

\$ 0.00

Multiple Dependent Claims \$135/270

\$ 40.00

Recording Fee \$40.

\$ 750.00

### TOTAL FEES FOR THE ABOVE APPLICATION

In the event there is attached hereto no check, or a check for an insufficient amount,  
please charge the fee to our Account No. 18-0002 and notify us accordingly.

The rights of priority are claimed under 35 USC §119 of Taiwanese Application No.  
89215578, filed September 8, 2000.

Respectfully submitted,

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November 6, 2000

Date

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PATENT DEPT 750

# FRONT-OPENING UNIFIED POD AUTO-LOADING STRUCTURE

## BACKGROUND OF THE INVENTION

### **Field of the Invention:**

5           The present invention relates to a FOUP (front-opening unified pod) auto-loading structure and, more particularly, to such FOUP auto-loading structure, which is suitable for use in the loading-in interface in a wafer manufacturing process to automatically close/open the cover of a FOUP.

### **10   Brief Description of the Prior Art:**

          In the fabrication of wafers, wafers are put in a unified pod, and the purity of the small inside space of the unified pod is well controlled. Because the purity of the small inside space of the unified pod is well controlled, the purity of the cleaning room is  
15   less critical. This measure saves much wafer manufacturing equipment cleaning cost. However, external dust or human body dust may be carried in the manufacturing equipment when opening the cover of the unified pod, causing a contamination to wafers.

## SUMMARY OF THE INVENTION

20           The invention has been accomplished to provide a FOUP auto-loading structure, which eliminates the aforesaid problem. It is the main object of the present invention to provide a FOUP auto-loading structure, which automatically loads in and

opens/closes the FOUP, preventing a contamination to wafers. It is another object of the present invention to provide a FOUP auto-loading structure, which forms a part of the automation of the wafer manufacturing process.

5           To achieve the aforesaid objects and according to one aspect of the present invention, the FOUP auto-loading structure of the present invention comprises a machine base, the machine base comprising a backboard, a table on the middle of the backward, and a base at a bottom side of the backboard, the backboard having an  
10 access on an upper side of the backboard; a carriage supported on the table and adapted to carry a FOUP, the carriage having an elongated hole through top and bottom sidewalls thereof; a sliding control mechanism mounted on the table to support the carriage and controlled to move the carriage on the table toward or away from  
15 the access; a clamp mechanism mounted on the bottom sidewall of the carriage, the clamp mechanism comprising a rail fixedly fastened to the bottom sidewall of the carriage, a screw rod disposed in parallel to the rail of the clamp mechanism, a slide threaded onto the screw rod of the clamp mechanism and adapted to  
20 move along the rail of the clamp mechanism upon rotary motion of the screw rod of the clamp mechanism, a motor adapted to rotate the screw rod of the clamp mechanism clockwise/counter-clockwise, and a clamp plate fixedly mounted on the slide of the clamp



carriage. According to still another aspect of the present invention, the cover close/open control mechanism comprises: a gate fitting and adapted to be moved in and out of the access of the backboard of the machine base, the gate having two through holes; two racks respectively fixedly fastened to a back sidewall of the gate, two support arms respectively extended from the racks and connected to the slide of the lifting mechanism; and a driving unit mounted on a back sidewall of the gate and controlled to close/open the cover of the FOUP being carried on the carriage, the driving unit comprising a transmission shaft, a motor controlled to rotate the transmission shaft, two rotary bolts respectively coupled to the transmission shaft and inserted through the through holes of said gate and adapted for engaging into the locating holes for turning by the transmission shaft to close/open the cover of the FOUP being carried on the carriage. According to still another aspect of the present invention, carriage comprises an escape hole, a motor fixedly mounted on a bottom sidewall thereof, and a locking bolt inserted through the escape hole and coupled to the motor at the carriage and rotated by the motor at the carriage to lock the FOUP on the carriage.

Other objects, advantages, and novel features of the invention will become more apparent from the following detailed description when taken in conjunction with the accompanying

drawings.

## BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective view of a FOUP auto-loading structure according to the present invention.

5        FIG. 2A is an exploded view of a part of the present invention, showing the arrangement of the clamp mechanism, the locking bolt and locking bolt control motor, the sliding control mechanism, and the table.

10       FIG. 2B is a sectional view of a part of the present invention, showing the arrangement of the clamp mechanism, the locking bolt and locking bolt control motor, and the sliding control mechanism between the carriage and the table.

15       FIG. 3 is a perspective view of the lower part of the present invention, showing the arrangement of the horizontal shifting mechanism and the lifting mechanism.

FIG. 4 is a perspective backside view of a part of the present invention, showing the arrangement of the lifting mechanism, the horizontal shifting mechanism, and the cover close/open control mechanism.

20       FIG. 5 is a perspective view in an enlarged scale of the upper part of FIG. 4.

FIG. 6 is a schematic drawing showing the operation of the present invention.

## DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to FIG. 1, a FOUP (front-opening unified pod) **8** is shown comprising an opening **81**, a cover **82** that closes the opening **81**, and a bottom panel **83**. The cover **82** has two locating  
5 holes **821** and **821'**. The bottom panel **83** comprises a positioning hole **831** at the center, a retaining portion **832** at a front side. The invention is used to load and open/close the cover **82** of the FOUP **8**.

The machine base, referenced by **1**, comprises a backboard  
10 **11** fixedly fastened to the loading port of the manufacturing equipment **9**. The back board **11** has a table **12** transversely disposed on the middle, a base **13** fixedly provided at the bottom side thereof, an access **110** disposed on the upper side of the backboard **11** above the table **12**, two parallel sliding slots **111** and  
15 **112** longitudinally vertically disposed below the table **12** (see also FIG. 4), and a packing member **113** fastened to the border of the access **110** at the front side and adapted to match with the opening **81** of the FOUP **8**.

The carriage, referenced by **2**, comprises three upright  
20 locating pins **201** disposed corresponding to three positioning grooves **833** of the bottom panel **83** of the unified pod **8** for the positioning of the FOUP **8** on the carriage **2**, two first upright detection pins **202** and **202'** corresponding to two recessed holes

834 and 834' on the bottom panel 83 of the FOUP 8 for detecting the front-stage manufacturing process or rear-stage manufacturing process, two second upright detection pins 203 and 203' corresponding to inspection holes 835 and 835' on the bottom panel 5 83 of the FOUP 8 for detecting the type of the unified pod 8 to be the 13-piece unified pod or 25-piece unified pod, and a third upright detecting pin 206 (see FIG. 2B). If the FOUP 8 does not match the upright detection pins 201, 202 and 203', the bottom panel 83 is tilted and cannot force down the third upright detection 10 pin 206. In this case, it means that the FOUP 8 is not correctly positioned. The carriage 2 further comprises an escape hole 204, and an elongated hole 205.

FIG. 2A shows the carriage 2 supported on a sliding control mechanism 21 above the table 12. The sliding control mechanism 15 21 comprises two parallel rails 22 and 22' fixedly mounted on the table 12, a front limit switch 221 and a rear limit switch 221' respectively disposed at front and rear ends of one rail 22, two slides 23 and 23' fixedly fastened to the bottom side wall of the carriage 2 and moved with the carriage along the rails 22 and 22', a 20 screw rod 25 fixedly mounted in the table 12, and a reversible motor 24 adapted to rotate the screw rod 25 clockwise/counter-clockwise. One slide 22 is threaded onto the screw rod 25. When starting the reversible motor 24 to rotate the



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screw rod 25 clockwise or counter-clockwise, the carriage 2 is moved with the slides 23 and 23' along the rails 22 and 22' toward or away from the access 110.

Referring to FIG. 2B and FIG. 2A again, a locking bolt control motor 31 and a clamp mechanism 4 are fixedly fastened to the bottom sidewall of the carriage 2. A locking bolt 3 is inserted through the escape hole 204 of the carriage 2, having a front end protruding over the topside of the carriage 2 for inserting into the positioning hole 831 on the bottom panel 83 of the FOUP 8 and a rear end coupled to the locking bolt 3. After insertion of the locking bolt 3 into the positioning hole 831 on the bottom panel 83 of the FOUP 8, the locking bolt control motor 31 is operated to rotate the locking bolt 3 through 90° angle to lock the FOUP 8. Limit switches 311 and 311' are provided to control forward/backward turning operation of the motor 31 through 90°. The front limit switch 221 and rear limit switch 221' control the locking bolt control motor 31 to rotate 90° forwards or backwards, so as to turn the unlock the locking bolt 3 between the locking position and the unlocking position. The clamp mechanism 4 comprises a rail 41 fixedly fastened to the bottom sidewall of the carriage 2, a screw rod 44 disposed in parallel to the rail 41, a slide 42 threaded onto the screw rod 44 and moved along the rail 41 upon rotary motion of the screw rod 44, a front limit switch 411 and a

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5 rear limit switch 411' respectively mounted on the front and rear  
ends of the rail 41, a motor 43 controlled to rotate the screw rod 44,  
and a clamp plate 45 fixedly mounted on the slide 42 and inserted  
through the elongated hole 205 of the carriage 2 and adapted to  
5 clamp the retaining portion 832 of the bottom panel 83 of the FOUP  
8. Rotating the motor 43 clockwise/counter-clockwise causes the  
clamp plate 45 to be moved with the slide 42 forwards or  
backwards, and therefore the clamp plate 45 is pressed on or  
released from the retaining portion 832 of the bottom panel 83 of  
10 the FOUP 8. Further, plastic rollers 46 are bilaterally provided at  
the topside of the clamp plate 45, which prevent damage to the  
retaining portion 832 upon pressing of the clamp plate 45 on the  
retaining portion 832, and eliminate the production of dust due to  
friction between the retaining portion 832 and the clamp plate 45.

15 Referring to FIG. 3, a horizontal shifting mechanism 5 and  
a lifting mechanism 6 are respectively installed in the base 13 of  
the machine base 1. The horizontal shifting mechanism 5 comprises  
two rails 51 and 51' horizontally arranged in parallel and extended  
perpendicular to the backward 11, a front limit switch 511 and a  
20 rear limit switch 511' respectively provided at the front and rear  
ends of one rail 51, a horizontal screw rod 53 disposed above the  
elevation of and in parallel to the rails 51 and 51', a platform 52  
threaded onto the screw rod 53 and slidably supported on the rails

51 and 51', and a motor drive 54 controlled to rotate the screw rod 53 clockwise/counter-clockwise. Rotating the screw rod 53 clockwise/counter-clockwise causes the platform 52 to be moved horizontally forwards/backwards along the rails 51 and 51' relative to the backboard 11. The lifting mechanism 6 comprises a screw rod and slide set 61 and a motor 65 vertically mounted on the platform 52 of the horizontal shifting mechanism 5. The screw rod and slide set 61 comprises a vertical rail 62 of U-shaped cross section having an open side facing to the outside, two guide rods 621 perpendicularly extended from the back sidewall of the vertical rail 62 and inserted through respective guide holes 114 on the backboard 11 and adapted to guide horizontal movement of the vertical rail 62 with the platform 52, a screw rod 64 longitudinally mounted in the vertical rail 62, a slide 63 threaded onto the screw rod 64 and moved along the vertical rail 62 upon rotary motion of the screw rod 64, and a limit switch 622 mounted in the vertical rail 62 and adapted to limit down stroke of the slide 63. The motor 65 is controlled to rotate the screw rod 64 clockwise/counter-clockwise, causing the slide 63 to be moved upwards/downwards along the vertical rail 62.

Referring to FIGS. 4 and 5 and FIG.1 again, a cover close/open control mechanism 7 is provided at the backside of the backboard 11. The cover close/open control mechanism 7 comprises

a gate 71 fitting the access 110 of the backboard 11, a packing member 712 fastened to the border of the gate 110 at the front side and adapted to match with the cover 82 of the FOUP 8, the gate 71 comprising two front positioning pins 713 adapted to engage the  
5 recessed positioning holes 822 and 822' on the cover 82 of the FOUP 8 and to stop the FOUP 8 from displacement and two through holes 711 corresponding to the locating holes 821 and 821' of the cover 82 of the FOUP 8, two racks 72 and 72' fixedly fastened to the back sidewall of the gate 71 and arranged in parallel, two  
10 support arms 73 and 73' respectively forwardly extended from the racks 72 and 72' below the gate 71 and inserted through the sliding slots 111 and 112 of the backboard 11 and fixedly connected to the slide 63 of the screw rod and slide set 61 of the lifting mechanism 6 for enabling the gate 71 to be moved horizontally and vertically by  
15 the horizontal shifting mechanism 5 and the lifting mechanism 6, and a driving unit 74 mounted on the back sidewall of the gate 71 and controlled to close/open the cover 82 of the FOUP 8. The driving unit 74 comprises a transmission shaft 76, a motor 75 controlled to rotate the transmission shaft 76, two rotary bolts 77  
20 and 77' respectively coupled to the transmission shaft 76 and inserted through the through holes 711 of the gate 71 and adapted for engaging into the locating holes 821 and 821' of the cover 82 of the FOUP 8 to open the cover 82 from the opening 81 of the FOUP

8. Further, at least one, for example, two detectors 78 are provided at the topside of the gate 71. After removal of the cover 82 from the opening 81 of the FOUP 8, the detectors 78 are moved with the gate 71 up and down relative to the FOUP 8 to detect the number and  
5 positioning of the wafers in the FOUP 8. There is also provided a detector 79 mounted on the back sidewall of the backboard 11 above the access 110, and adapted to detect protrusion of wafers in the FOUP 8, so as to prevent damage to the wafers upon closing/opening of the cover 82.

10 As stated above, when the FOUP 8 is carried to the carriage 2 by labor or an automatic truck, the correct positioning of the FOUP 8 is detected by the upright detection pins 202 and 203, and then the third upright detection pin 206 is pressed down to turn on the motor 31, causing the motor 31 to rotate the locking bolt 3 in  
15 one direction through 90°, and therefore the locking bolt 31 is forced into engagement with the positioning hole 831 on the bottom panel 83 of the FOUP 8. At the same time, the motor 43 of the clamp mechanism 4 is turned on to rotate the screw rod 44, causing the clamp plate 45 to be moved with the slide 42 and forced into  
20 engagement with the retaining portion 831 of the bottom panel 83 of the FOUP 8. This double-locking effect keeps forward movement of the FOUP 8 in course. The sliding control mechanism 21 is then driven to move the carriage 2 and the FOUP 8 forwards, causing the

opening 81 of the FOUP 8 to be forced into close contact with the packing member 113 of the access 110. Therefore, when the motor 75 of the driving unit 74 is started to rotate the rotary bolts 77 and 77' in opening the cover 82, the FOUP 8 is maintained free from contamination. Thereafter, the horizontal shifting mechanism 5 is operated to move the cover 82 horizontally backwards, and then the lifting mechanism 6 is operated to lower the cover 82, for allowing the internal mechanical arm of the manufacturing equipment 9 to pick up the wafers from the FOUP 8. On the contrary, when closing the cover 82 on the FOUP 8, the aforesaid procedure is repeated reversely. Therefore, the FOUP 8 can be automatically opened and closed in the manufacturing equipment 9 without causing contamination.

Although the present invention has been explained in relation to its preferred embodiment, it is to be understood that many other possible modifications and variations can be made without departing from the spirit and scope of the invention as hereinafter claimed.

## WHAT IS CLAIMED IS:

1. A front-opening unified pod auto-loading structure adapted to load in a FOUP (front-opening unified pod), comprising:

a machine base, said machine base comprising a backboard,

5 a table on the middle of said backward, and a base at a bottom side of said backboard, said backboard having an access on a upper side of said backboard;

a carriage supported on said table and adapted to carry said FOUP, said carriage having an elongated hole through top and  
10 bottom sidewalls thereof;

a sliding control mechanism mounted on said table to support said carriage and controlled to move said carriage toward or away from said access;

a clamp mechanism mounted on the bottom sidewall of said  
15 carriage, said clamp mechanism comprising a rail fixedly fastened to the bottom sidewall of said carriage, a screw rod disposed in parallel to the rail of said clamp mechanism, a slide threaded onto the screw rod of said clamp mechanism and adapted to move along the rail of said clamp mechanism upon rotary motion of the screw  
20 rod of said clamp mechanism, a motor adapted to rotate the screw rod of said clamp mechanism clockwise/counter-clockwise, and a clamp plate fixedly mounted on the slide of said clamp mechanism and inserted through the elongated hole of said carriage and

adapted to be moved with the slide of said clamp mechanism to clamp the FOUP being carried on said carriage;

a horizontal shifting mechanism, said horizontal shifting mechanism comprising rail means fixedly mounted on the base of said machine base, a horizontal screw rod disposed in parallel to the rail means of said horizontal shifting mechanism, a platform threaded onto the screw rod of said horizontal shifting mechanism, and a motor drive controlled to rotate the screw rod of said horizontal shifting mechanism clockwise/counter-clockwise for causing said platform to be moved horizontally along the rail means of said horizontal shifting mechanism toward/away from the backboard of said machine base; and

a lifting mechanism, said lifting mechanism comprising a motor and a screw rod and slide set vertically mounted on the platform of said horizontal shifting mechanism, said screw rod and slide set comprising a vertical rail, a screw rod longitudinally mounted in said vertical rail, a slide threaded onto the screw rod of said lifting mechanism and moved along said vertical rail upon rotary motion of the screw rod of said lifting mechanism.

2. The front-opening unified pod auto-loading structure as claimed in claim 1, wherein further comprising a cover close/open control mechanism moved with the slide of said lifting mechanism and controlled to close/open the cover of the FOUP being carried



on said carriage.

3. The front-opening unified pod auto-loading structure as claimed in claim 2, wherein said cover close/open control mechanism comprises:

5 a gate fitting and adapted to be moved in and out of the access of said backboard of said machine base, said gate having two through holes;

two racks respectively fixedly fastened to a back sidewall of said gate, two support arms respectively extended from said  
10 racks and connected to the slide of said lifting mechanism; and

a driving unit mounted on a back sidewall of said gate and controlled to close/open the cover of the front-opening unified pod being carried on said carriage, said driving unit comprising a transmission shaft, a motor controlled to rotate said transmission  
15 shaft, two rotary bolts respectively coupled to said transmission shaft and inserted through the through holes of said gate and adapted for engaging into the locating holes for turning by said transmission shaft to close/open the cover of the FOUP being carried on said carriage.

20 4. The front-opening unified pod auto-loading structure as claimed in claim 1, wherein said sliding control mechanism comprises rail means, a screw rod disposed in parallel to the rail means of said shifting control mechanism, slide means threaded



FOUP being carried thereon.

9. The front-opening unified pod auto-loading structure as claimed in claim 1, wherein said backboard of said machine base comprises two parallel sliding slots longitudinally extended below  
5 said table.

10. The front-opening unified pod auto-loading structure as claimed in claim 1, wherein said backboard comprises a packing member mounted around the periphery of said access at a front side.

10 11. The front-opening unified pod auto-loading structure as claimed in claim 3, wherein said gate comprises a packing member mounted around the periphery of a front side thereof.

12. The front-opening unified pod auto-loading structure as claimed in claim 1, wherein said gate further comprises a plurality  
15 of positioning pins adapted to engage respective recessed positioning holes on the cover of the FOUP being carried on said carriage.

13. The front-opening unified pod auto-loading structure as claimed in claim 1, wherein said clamp plate of said clamp  
20 mechanism comprises at least one roller disposed at a top side thereof.

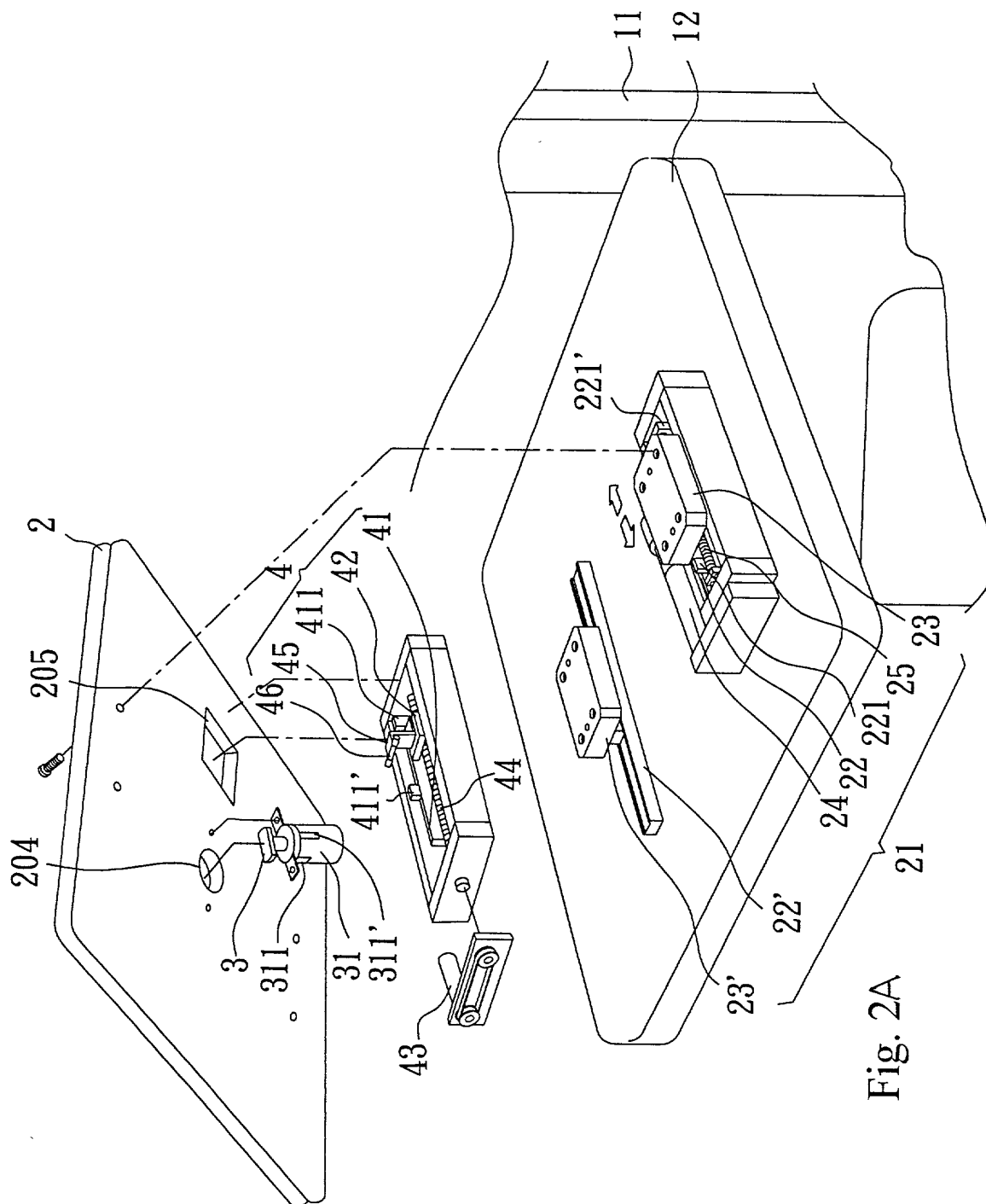
14. The front-opening unified pod auto-loading structure as claimed in claim 1, wherein said backboard of said machine base



## ABSTRACT OF THE DISCLOSURE

The invention includes mainly a machine base, a carriage, a sliding control mechanism, a clamp mechanism, a horizontal shifting mechanism, and a lifting mechanism. The FOUP  
5 (front-opening unified pod) is put on the carriage and held down by a clamp plate of the clamp mechanism, and then moved and contacted to a gate on an access at a backboard of the machine base, and then a cover of the FOUP is opened by a cover close/open control mechanism at the back of the gate, and then the cover is  
10 carried backwardly away from the FOUP by the horizontal shifting mechanism and then lowered with the lifting mechanism. The cover is closed on the FOUP when reversing the procedure. The automatic FOUP cover closing/opening operation prevents wafers from contamination.

Fig. 1



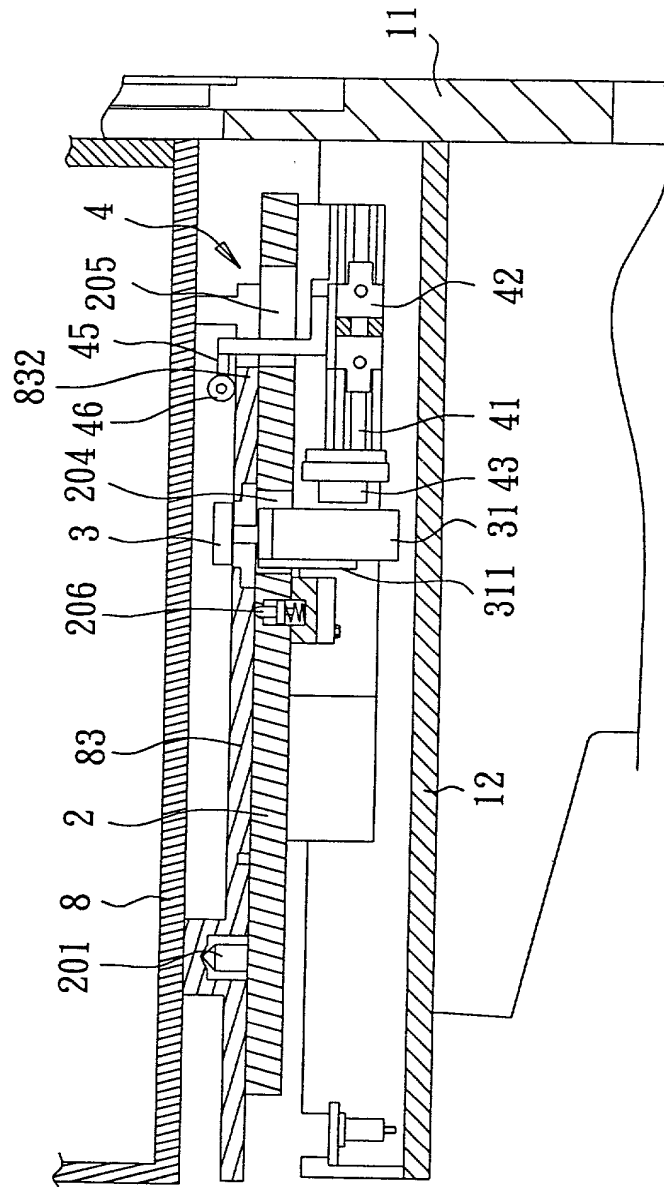
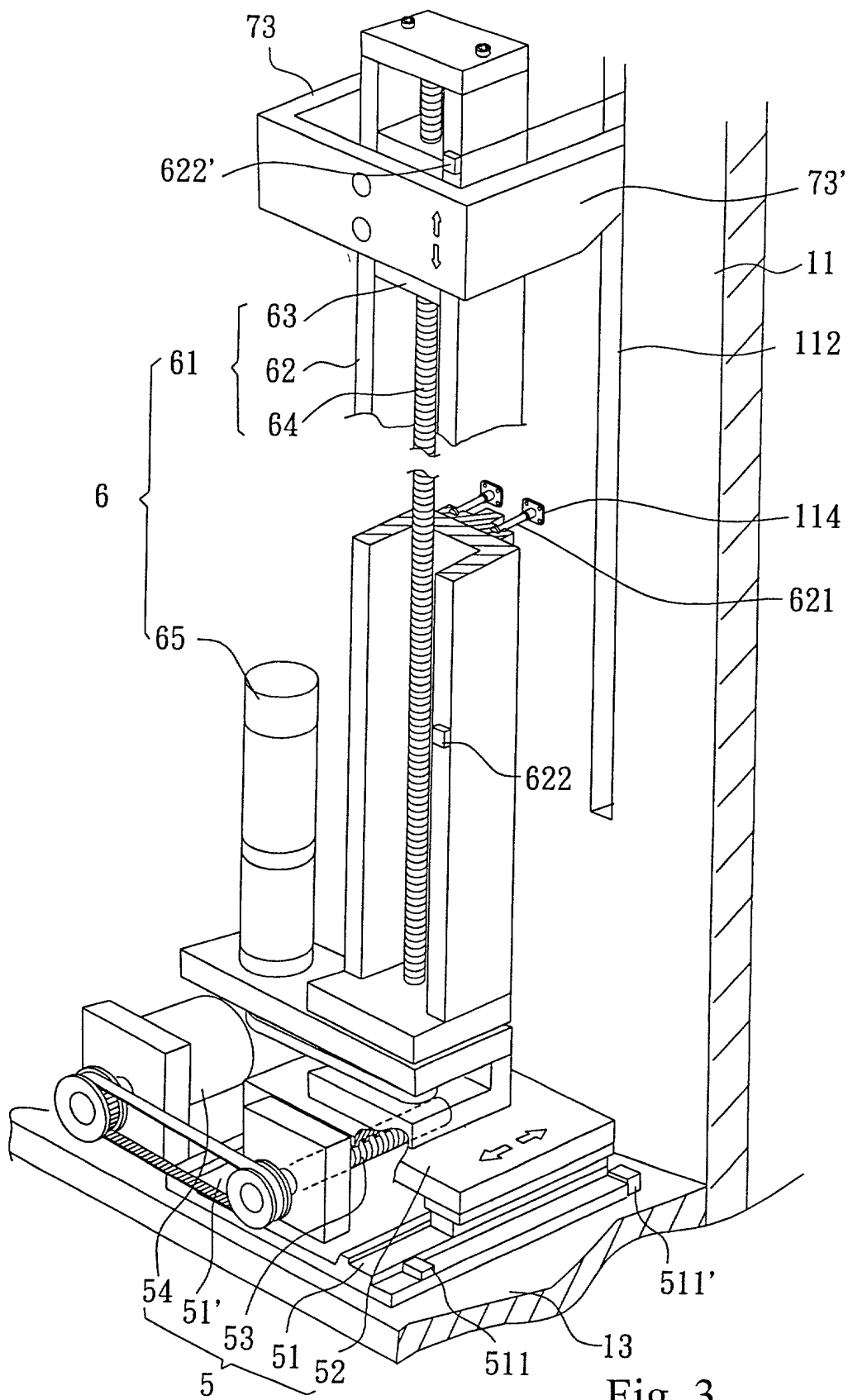


Fig. 2B





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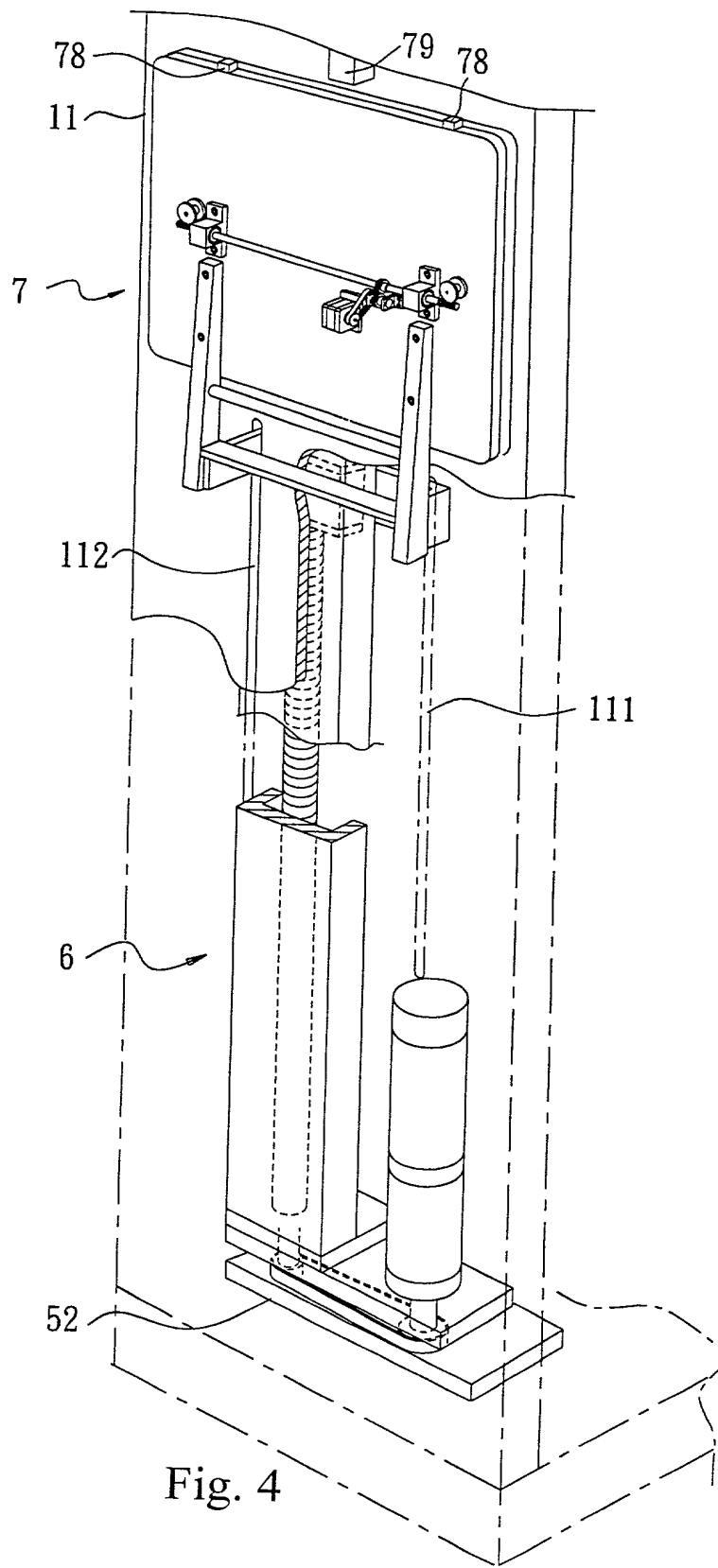


Fig. 4

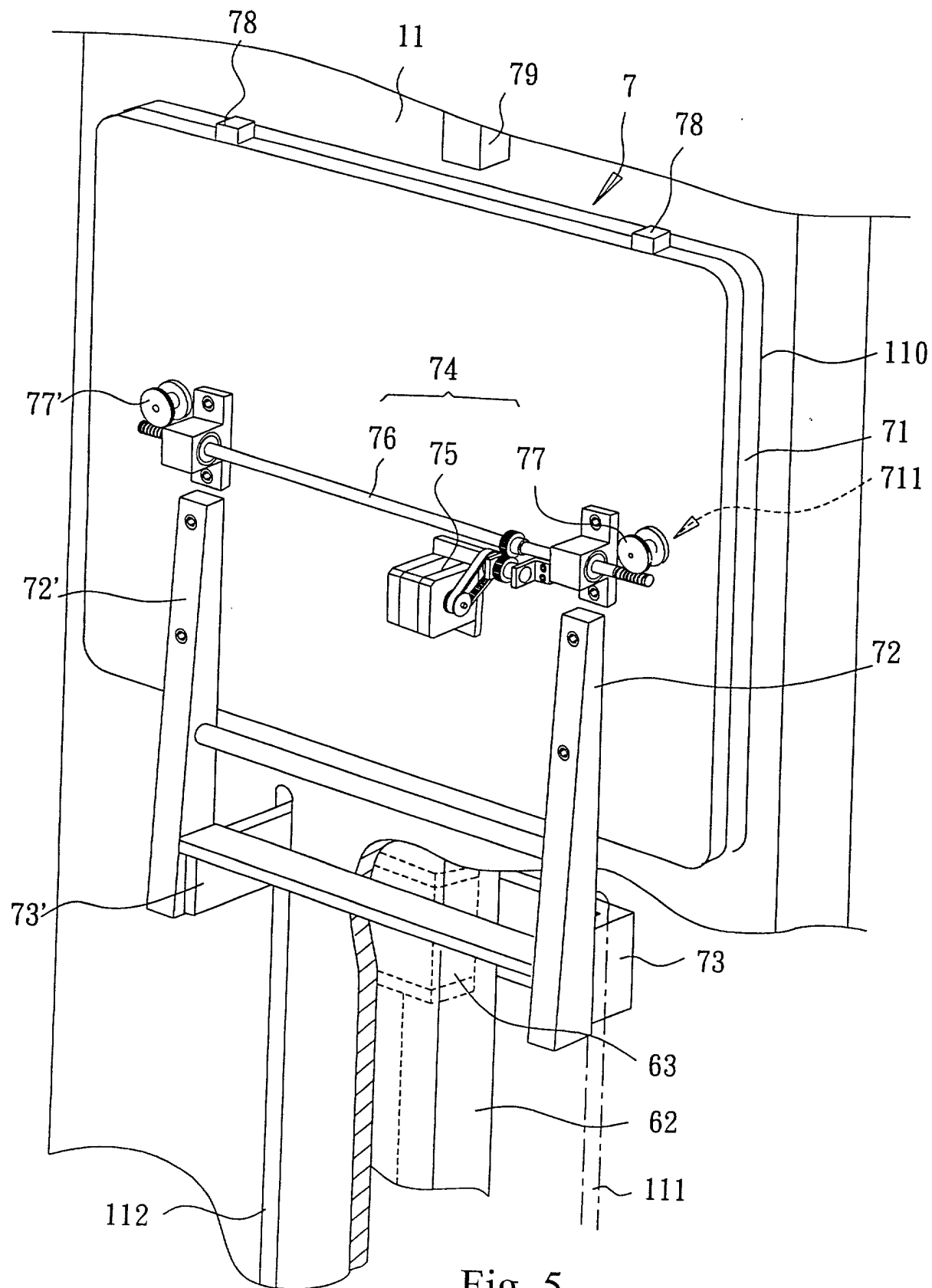


Fig. 5

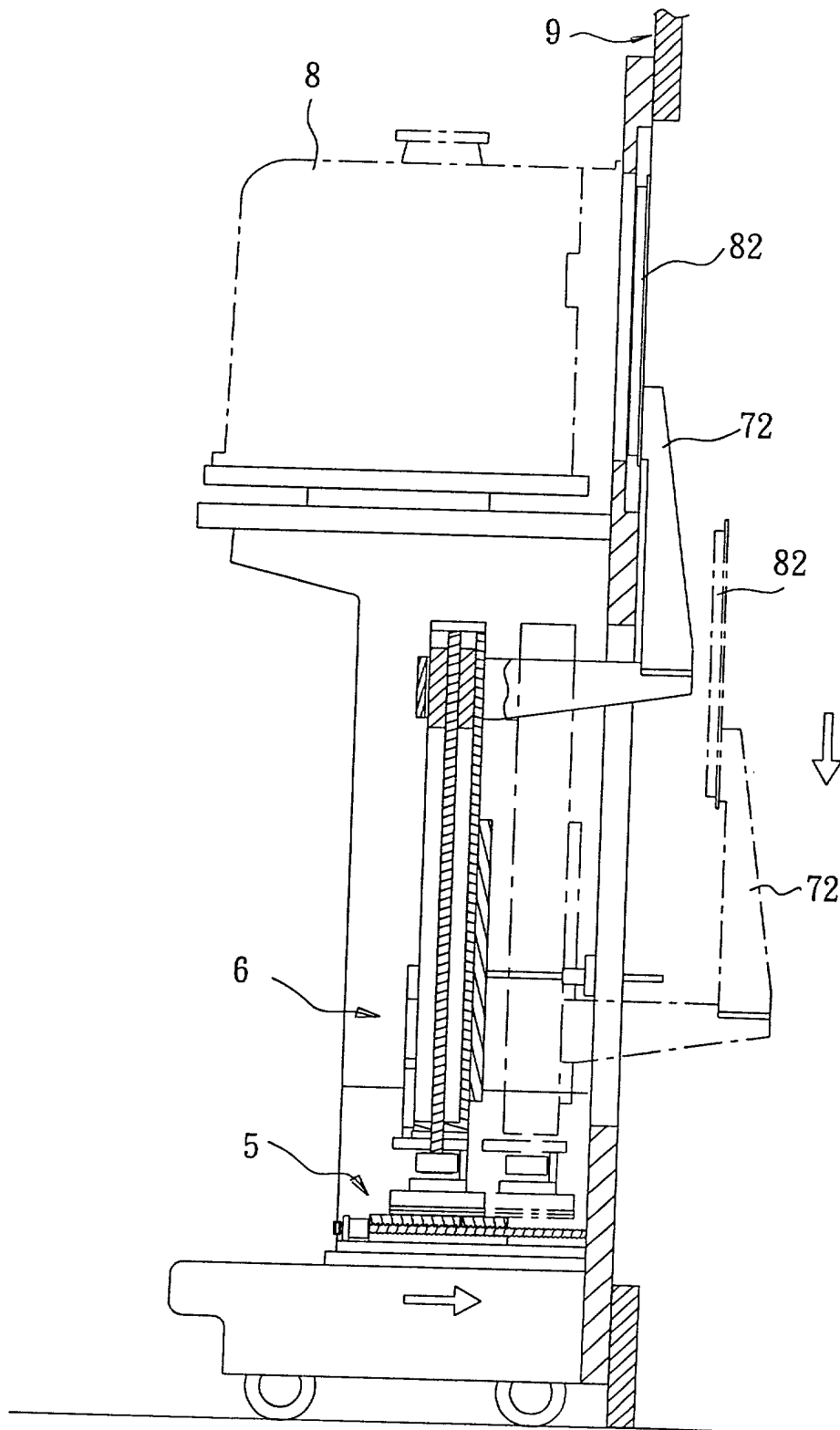


Fig. 6

**DECLARATION FOR UNITED STATES PATENT APPLICATION,  
POWER OF ATTORNEY, DESIGNATION OF CORRESPONDENCE ADDRESS**

As a below named inventor, I hereby declare that my residence, post office address and citizenship are as stated below next to my name, and that I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled

**"Front-opening Unified Pod Auto-loading Structure"**

the specification of which

☒ is attached hereto.  
☐ was filed on \_\_\_\_\_, as Application Serial No. \_\_\_\_\_  
 and was amended on \_\_\_\_\_ [if applicable].  
☐ was filed under the Patent Cooperation Treaty on \_\_\_\_\_,  
 Serial No. \_\_\_\_\_, the United States of America being designated.

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims.

I acknowledge the duty to disclose to the Patent and Trademark Office information known to me to be material to patentability as defined in Title 37, Code of Federal Regulations, §1.56(a).

I hereby claim foreign priority benefits under Title 35, United States Code, §119 of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application on which priority is claimed:

Prior Foreign Application(s)		Date Filed	Priority Claimed
Number	Country		Yes No
89215578	Taiwan R. O. C.	Sept. 8, 2000	X

I hereby appoint the following attorneys to prosecute this application and to transact all business in the United States Patent and Trademark Office connected therewith: Steven M. Rabin (Reg. No. 29,102), Thomas M. Champagne (Reg. No. 36,478), Robert H. Berdo, Jr. (Reg. No. 38,075), and Charles W. Peterson, Jr. (Reg. No. 34,406), 1725 K Street, N.W., Washington, D.C. 20006, Telephone: (202) 659-1915; Fax: (202) 659-1898. Address all correspondence to RABIN & CHAMPAGNE, P.C., 1725 K Street, N.W., Suite 1111, Washington, D.C. 20006.

The undersigned hereby authorizes the U.S. attorneys named herein to accept and follow instructions from the undersigned's assignee, if any, and/or, if the undersigned is not a resident of the United States, the undersigned's domestic attorney, patent attorney, patent agent, or patent representative as to any action to be taken in the Patent and Trademark Office regarding this application without direct communication between the U.S. attorneys and the undersigned. In the event of a change in the person(s) from whom instructions may be taken, the U.S. attorneys named herein will be so notified by the undersigned.

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under §1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

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DECLARATION FOR UNITED STATES PATENT APPLICATION,  
POWER OF ATTORNEY, DESIGNATION OF CORRESPONDENCE ADDRESS

Page 2 of 2

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